





U.S. Department of Commerce
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National Bureau of Standards

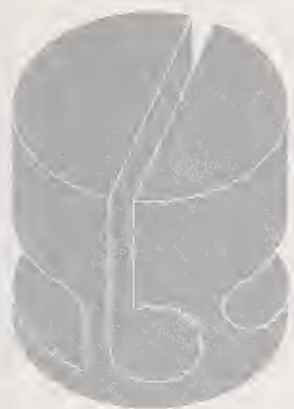
Richard W. Roberts, Director

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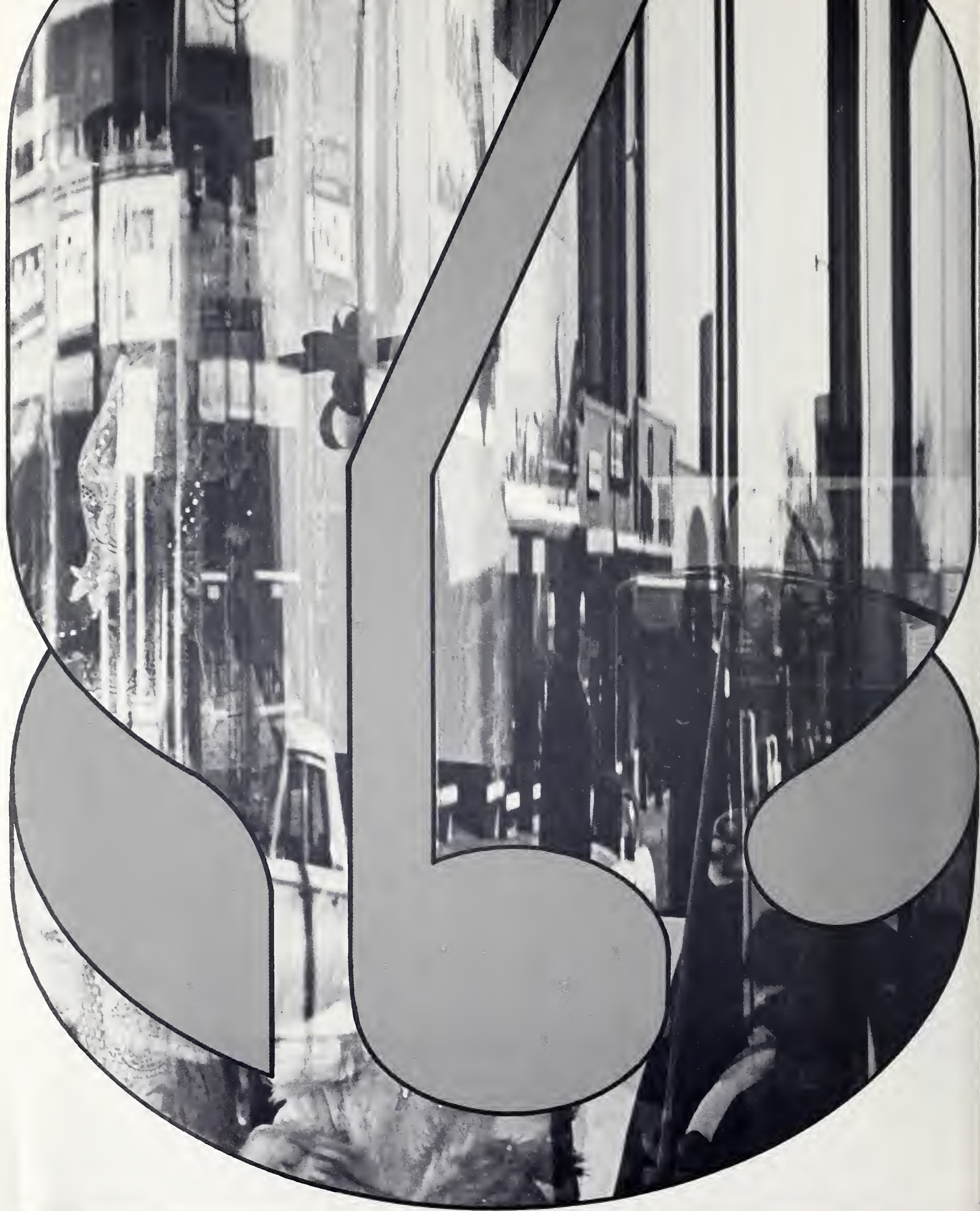
about the cover

The stylized initials created in a kilogram . . . the only standard of measure still defined by a physical artifact . . . symbolize the old and the new at the National Bureau of Standards, established in 1901 as the nation's physical science and measurement laboratory.

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There is much concern today over the depletion of national resources. Scientific and engineering talent, and the institutions that focus this talent on national problems, are more than ever of great significance. In that light, the Commerce Department's National Bureau of Standards is a resource of the first order, created and maintained by the American people to help set standards for daily living.

By standards for daily living, I mean that vast, often unnoticed network of measurements and standards that enrich our daily lives. On a simple plane, consider how chaotic our affairs would be if we had no means of measuring time. In a more technical sense, the complex products of modern industry would be impossible without measurements that provide understanding of materials and control of their fabrication. Measurements also affect us in a very personal way, as when your doctor takes your blood pressure or has your cholesterol level determined.

It is our job at the National Bureau of Standards to provide the firm foundation for measurements and standards. Sometimes this involves working at the outer limits of physical science; at others, it means determining the amount of noise produced by a child's toy cap gun. No matter what the challenge, NBS applies its talents in providing standards for daily living.

Richard W. Roberts
Director

Standards For Daily Living



The Gaithersburg campus.

We take measurements and the standards obtained from measurements for granted, just as we accept the many aspects of daily living. But without them we would be at a loss; we would not be able to enjoy our current "standard" of living, and our lives would be less productive. Measurement-related activities are a huge factor in the American economic system, accounting for about 6 percent of the Gross

National Product, or \$70 billion annually.

The focal point for measurement standards in the United States is the National Bureau of Standards, an agency of the Department of Commerce. The Bureau, which was established by Congress in 1901, is essential to modern American life. Respected since its inception by the trade and technical communities, the Bureau also has a long tradition of



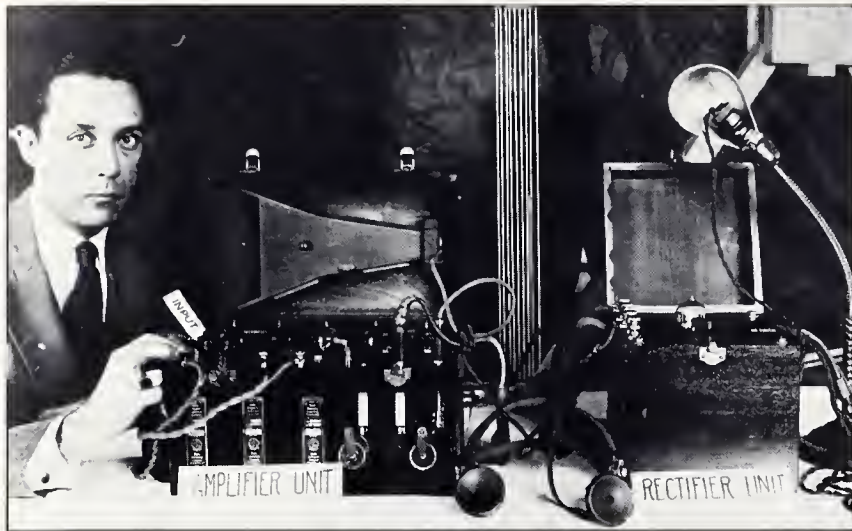
Research reaches the marketplace.

communicating the practical results of its research to the general public. This effort received additional attention as NBS moved into the mid-1970's.

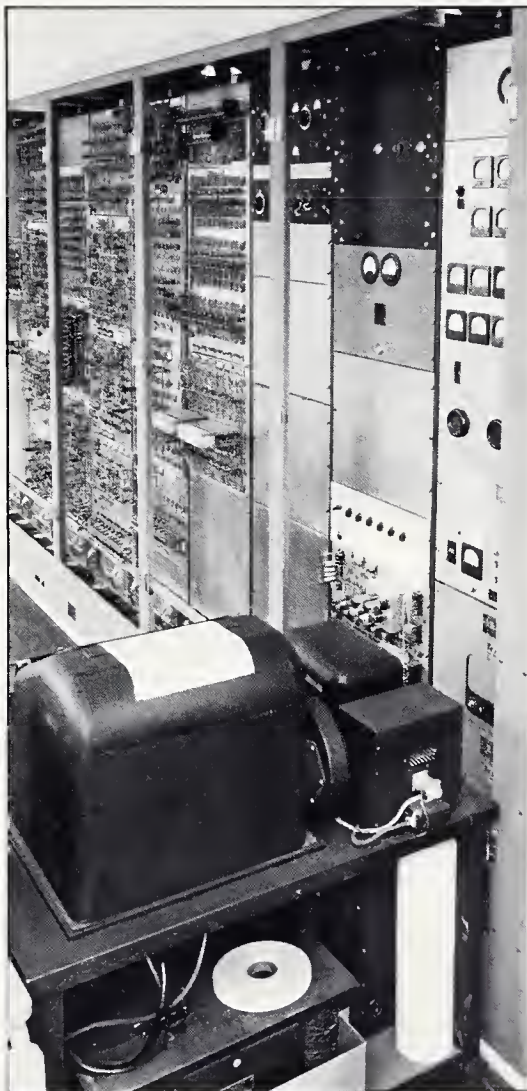
The development of a highly complex and technical society requires basic norms and agreements to which all men can adhere. This forms the nucleus of our system of laws and justice and it underlies our flow of goods and services to the marketplace. It is in

the latter area that the Bureau has made a vital contribution in the last 73 years. Today, with 3,100 employees located in Gaithersburg, Md., and Boulder, Colo., NBS is one of the nation's largest physical sciences and measurements laboratories.

Historical Pioneer



NBS invention made commercial radio possible.



One of the first electronic computers.

From its beginnings the Bureau envisioned its scope as wider than simply the official keeper of weights and measures for the United States. It extended its scientific and technological resources to American industry and the American consumer. At the outset NBS played a major role in two developments that were to affect the lives of every American—electricity and radio.

Standards and standard measurement techniques for electricity were developed at NBS. This led to pioneering work in radio which, in 1922, resulted in the invention of the rectifier, an electronic device that permitted radios to operate on household electricity and gave birth to a new industry. NBS also developed radio direction finders for airplane navigation and radiosondes for transmitting data back from weather balloons. NBS helped usher in the atomic age by contributing to processes by which uranium and graphite were purified in the early 1940's. And it was present at the birth of the computer age with the construction of one of the nation's first electronic computers in 1950.

Catalyst for Change

The ability to keep ahead of the times has characterized the Bureau's work. Today NBS is laying groundwork for automation technology that will relieve man from tedious and hazardous jobs while increasing the nation's productivity. Through cooperative efforts with the retailing, banking, and other service sectors of our economy, the Bureau is advancing the application of computer technology for public benefit. In this it is serving as a catalyst for change.

So, too, is NBS involved in other issues of the mid-1970's. Energy conservation, materials research, environmental control and consumer protection are dominant themes. The Bureau has active research programs in each of these areas. In fact, NBS is a mixture of stability and change—on the one hand maintaining and improving upon the nation's standards of measure and, on the other, performing the basic laboratory work that promotes technological progress. Through its first 73 years the Bureau has been a center of excellence and an effective spokesman for science and technology within the Federal government.

Information Programs

NBS addresses a variety of audiences. It has developed programs, such as the National Standard Reference Data System, for evaluating and communicating data to the scientific and engineering communities. And it also communicates scientific and technical information in a variety of ways to the general public. This annual report presents highlights of Bureau programs during the fiscal year which ended June 30, 1974. Anyone wishing additional information on any NBS activities and programs is invited to contact the Office of Information Activities, National Bureau of Standards, Washington, D.C. 20234.



Laser instruments measure seismic disturbances.

The Year In Review

Expanding Measurement Capabilities

The Bureau made significant progress in fiscal 1974 in the area of fundamental measurement. Through the aid of the latest in electronics technology, for example, Bureau scientists determined the weight of an atom with an accuracy of 1 part in a million. This remarkable achievement was one of a series of complex and exacting experiments which resulted in a new, more accurate determination of the Avogadro constant (the number of atomic mass units in 1 gram). In practical terms it means progress towards replacing

kilogram weights with an atomic standard for mass. Bureau scientists also measured the earth's strain as recorded by laser instruments in a Colorado mine tunnel. They found, apart from occasional seismic disturbances, that the earth is relatively quiet.

Industry and commerce are big beneficiaries of NBS measurement expertise. In the oil industry, for example, density of crude oil is used to determine the quantity of oil transferred. During fiscal 1974 the Bureau signed a 5 year contract with the American Petroleum Institute to update



Water towers in Kuwait studied for corrosion problems.

60-year-old standards of density. The agreement calls for NBS to obtain samples from oil fields around the world, measure their density at different temperatures and establish a new set of reference tables.

The Bureau, in cooperation with electric utility companies, began studies to determine how accurately power companies calibrate watt-hour-meter standards and utilize them to meter the energy used by consumers. In the initial phase, the measurement processes of 30 utilities were examined. Most were within acceptable tolerance limits but 11 percent exceeded the limits by varying degrees. The program is being continued and enhanced so that all power laboratories in the country will have access to this service and can improve their measurement accuracies.

NBS has an interest in international measurement standards as well. It serves as a scientific and technical resource for the U.S. State Department and actively promotes international standardization. Some of its fiscal 1974 projects included improving the quality of rubber from Thailand, consulting with Israeli specialists on trace analysis and dealing with corrosion problems in Kuwait.

The Bureau established the U.S. Advisory Committee for Legal Metrology to help ensure adequate representation of the U.S. viewpoint in the International

Organization of Legal Metrology. The latter is a treaty organization of 43 nations whose purpose is to establish minimum technical requirements which weighing and measuring instruments must possess in order for them to be accepted by the member nations and be used internationally. These technical requirements are contained in international recommendations which are intended to be adopted as national law or regulation. These international activities help to improve the flow of trade among nations.



Calibrating watt-hour meters.

Toward Solving the Energy Problem

Oil. That once cheap source of energy for moving man across his planet suddenly became expensive. One way that our government responded to this situation was to encourage energy conservation by the public. NBS was deeply involved in these efforts.

The Bureau initiated a program to help inform potential buyers of home appliances about how much energy the appliances consume. The first project in this effort was the development of energy conservation labels for room air conditioners. Other appliances and equipment to be labeled in fiscal 1975 include refrigerators, freezers and hot water heaters.

The Bureau also developed guidelines for energy conservation in the design of new buildings. These guidelines will assist in providing a basis for voluntary standards which state and local governments may adopt.

To demonstrate energy conservation, the Bureau collaborated with the General Services Administration in the design of a Federal office building in Manchester, N.H. The building is expected to save about one-third the energy used by a similar, conventionally-designed building. NBS will evaluate and determine which of the building's energy-saving features are most effective. The Bureau also began work with the New York City Board



NBS townhouse used for energy efficiency study.



Adding insulation to check energy savings.

of Education, under National Science Foundation sponsorship, to design an energy-efficient school building.

In work on the Bureau grounds, scientists and engineers studied a prefabricated townhouse to determine how it might be made more energy efficient. They found that adding insulation in the structure could save up to 55 percent of the energy required for heating. Additionally, when the outdoor temperature was about -6°C (21°F), it was shown that savings of about 12 percent of the heating energy could be realized by turning the thermostat back from 24°C (75°F) to 18°C (65°F) at night. Three related NBS publications, "Home Energy Saving Tips," "7 Ways to Reduce Fuel Consumption in Household Heating" and "11 Ways to Reduce Energy Consumption and Increase Comfort in Household Cooling," continued to receive wide distribution in fiscal 1974.

Solar energy was talked about as a long-term solution to the energy crisis and the Bureau was asked to participate in some of the preliminary research. If solar energy is to be used on a large scale in this country, certain measures of performance have to be established. Just what constitutes an effective solar heating and cooling system? NBS was given a mandate by Congress to answer this question—particularly with respect to residential

buildings. As part of this project, NBS fitted the townhouse mentioned above with a solar heating and cooling system and will monitor its performance.



Improving Man's Environment

While energy became a major concern in fiscal 1974, the nation's commitment to a clean environment continued and NBS provided several major technological advances in the field of pollution control. Noise pollution has become an increasingly important issue, especially among urban Americans. NBS has been working with several government agencies to assess existing procedures or develop new methods for the measurement and characterization of the noise environment.

Working for the Environmental Protection Agency, NBS completed an evaluation of a number of commercial instruments which measure occupational noise exposure. For the Department of Housing and Urban Development, Bureau engineers designed, fabricated and began evaluating a prototype urban noise measurement system. NBS psychologists continued to work toward the development of improved procedures for

determining human response to various types of noise.

In the area of source emission, NBS completed another phase of an ongoing program to measure tire noise for the Department of Transportation; developed procedures for measuring noise emission from medium and heavy-duty trucks and portable air compressors for the Environmental Protection Agency, and developed a procedure for measuring the noise produced by paper caps used in toy pistols for the Consumer Product Safety Commission.

As the result of a fish kill on the James River in Virginia, NBS developed, in collaboration with the State of Virginia, a sensitive monitor to detect minute traces of chlorine in water. The monitor discovered high levels of chlorine coming from a sewage treatment plant that emptied into the James. Alerted to the problem, the plant cut back its chlorine usage and chlorine levels in the river dropped. The portable monitor device aids pollution



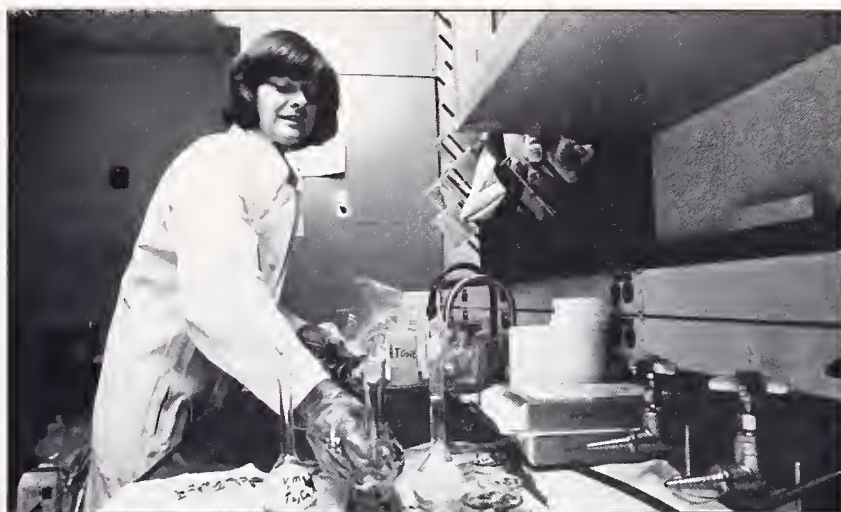
control officials in assessing water quality more easily and quickly.

Other NBS scientists studying tiny organisms from the Chesapeake Bay discovered that organisms absorb and convert mercury into its more deadly form, called methylmercury. Conversion occurs also when the organisms absorb tin and react with mercury. The work provides a means of assessing the amount of toxic mercury in polluted waters and assists officials in setting pollution controls.

NBS also provided measurement checks on the radioactive effluents from nuclear power plants. The operators of these plants and regulatory agencies such as the Atomic Energy Commission, Environmental Protection Agency and the various states were provided with radioactivity standards for measurement comparison. NBS also sent these groups samples of materials to be identified. The results were reported back to NBS. The Bureau then told these groups of the accuracy and reliability of their measurement.

In the field of air pollution control, NBS researchers developed an instrument to measure accurately the number, size and distribution of particles of soot, dust and other matter in the atmosphere. Previous instruments were often unreliable and the NBS device reduced the margin of error.

During the year, NBS presented the Environmental Protection Agency with three calibration standards for measuring automobile exhaust emissions. These will enable the Environmental Protection Agency to provide daily working standards to assure compliance with Federal automotive emission laws. In other words, NBS provided the base against which all emission standards will be ultimately judged.



Chesapeake Bay organisms studied for toxic metal content.



Portable chlorine monitor used to assess water quality.

Striving for Safer Products

To protect consumers, NBS developed an instrument which duplicates the response of human finger tissue to the surface temperature of a toaster, iron or other home appliance and quickly tells whether the surface is too hot for safe human contact. The instrument, called a "thermesthesiometer," will be produced commercially by a private firm for use by appliance manufacturers in designing safety into new products. The Consumer Product Safety Commission also plans to distribute the instrument to field offices for testing purposes.

Law enforcement officials know that many homes built since World War II with wooden doors

and frames can easily be entered by an intruder with only a few kicks or a screwdriver. As a result, the Bureau was asked to prepare a voluntary performance standard for the security of exterior residential doors. The standard should lead to more "burglar-proof" doors in homes and apartments.

NBS developed a performance standard for police riot helmets for the National Institute of Law Enforcement and Criminal Justice. NBS technical work showed that some of the riot helmets afforded policemen little protection. Standard test methods were developed to promote uniform quality in the manufacture and purchase of helmets. The test methods cover impact strength, penetration, resistance, strength retention and peripheral vision.

There has been mounting public concern over the increasing toll of life and property taken by fire. Recognizing this concern, NBS reorganized its fire research programs and strengthened them by opening a new, \$2 million fire research facility at its Gaithersburg laboratories.

NBS has long been a leader in research on clothing fires. Its research provided the basis for the first flammability standard for children's sleepwear (sizes 0-6X) issued in 1971. Subsequent research led to publishing a second, complementary standard



Bureau research led to flammability standards for children's sleepwear



NBS-developed device measures burn potential of appliances

on May 1, 1974. It covers children's sleepwear sizes 7 through 14 and takes effect May 1, 1975. After that date all children's sleepwear sold to the public must conform to Federal flammability standards as prescribed by the Consumer Product Safety Commission.

Another public concern in fiscal 1974 was the problem of high-rise building fires. NBS studied 10 Veterans Administration hospitals and a high-rise apartment building in Jersey City, N.J., to determine paths of smoke movement through corridors, elevator shafts and stairwells. The studies tested fire prevention and warning systems, such as sprinklers and smoke detectors. NBS also published a report analyzing the problem of occupant safety in high-rise fires. It urged a coordinated system for alerting occupants and leading them to safety through the use of either stairways or fire-safe areas on various floors.

NBS developed a test method for determining the smoke generation potential of materials which was adopted as a tentative standard by the National Fire Protection Association. Knowledge of the smoke generation potential of materials is crucial because inhalation of smoke and toxic gases, rather than burn injuries, accounts for the majority of fire deaths. One way to minimize this danger is to select

materials with a low potential for smoke generation for use in critical areas such as exitways and air conditioning ducts.

A topic studied intensively in fiscal 1974 was disaster mitigation, particularly from high winds. Working with the Agency for International Development and the Philippine government, NBS began examining the design and construction of low-cost housing to make it more wind resistant. This work will continue for two more years with the results being made available to the governments of the Philippines, Bangladesh and other countries where high winds are an environmental problem.

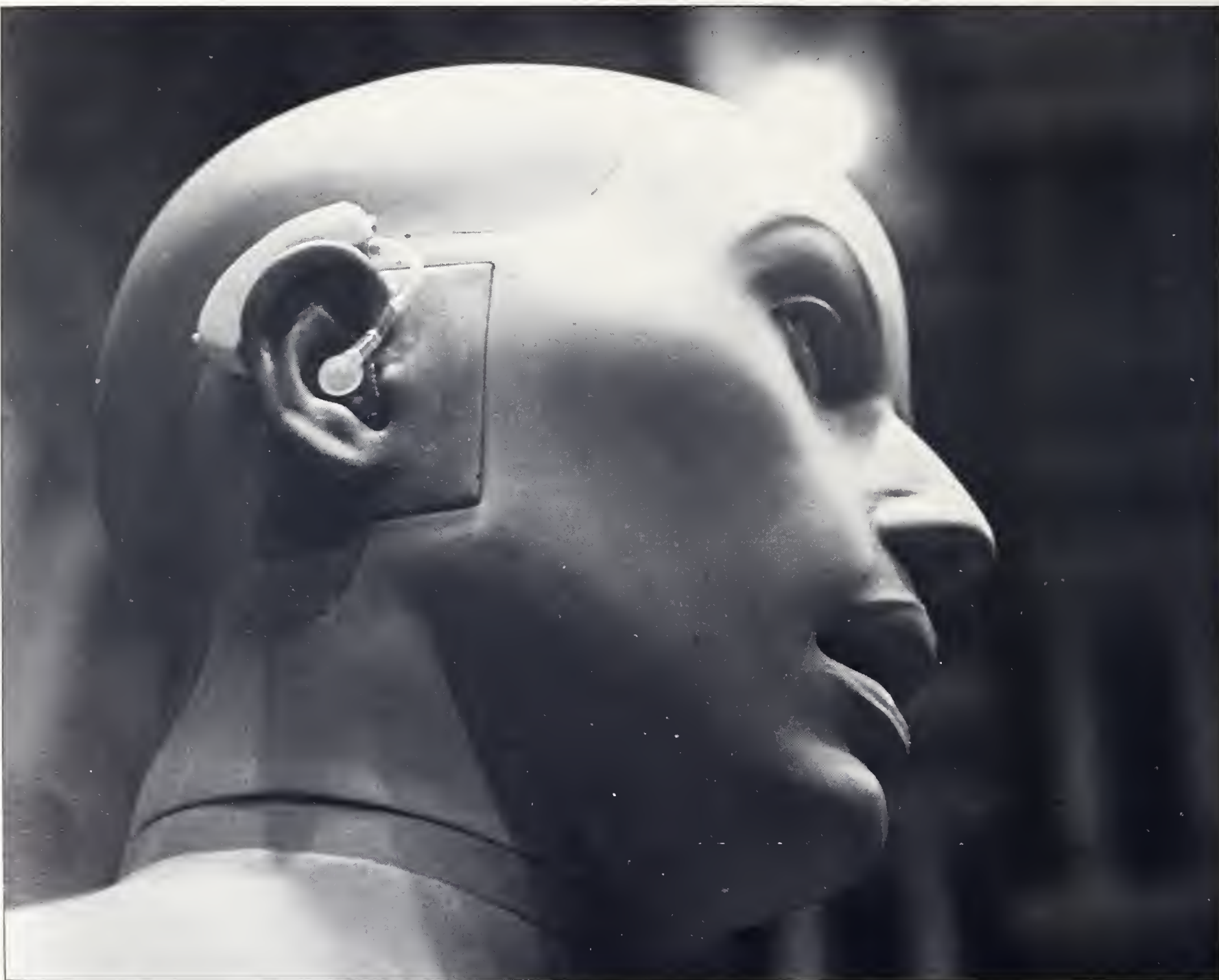


Bureau studied smoke movement in high-rise fires.

Aiding Health Care

The reliability of machines has become of vital importance in the health field. For example, high-frequency sound waves (ultrasound) are coming into increasing use as a means of

obtaining pictures of internal organs. Safe operation of these machines depends upon accurate calibration of the power (sound) levels. During fiscal 1974, the Bureau compared its ultrasonic



Three hundred types of hearing aids tested by NBS.

calibration techniques with those of the Department of Health, Education and Welfare. The closeness of the two measurements provides increased confidence in the accuracy of ultrasonic scanning devices.

NBS also measured the important physical and chemical properties of bone cement used by surgeons to restore hip joints. By getting a better understanding of the performance characteristics of the cement, NBS will help to improve the safety and reliability of the product.

In a unique use of the medium of television, the Public Broadcasting System tested a system developed by NBS which allows captions to appear on specially equipped TV sets for deaf viewers. By reading word strips that move across the television screen, many hearing-impaired persons may soon be able to enjoy television. Initial reactions from deaf viewers were enthusiastic.

NBS tested some 300 types of hearing aids for the Veterans Administration, the country's largest single purchaser of hearing aids. NBS test results, used by the VA in making purchases, are made available to the general public by the VA.

Providing technical support to the Department of Housing and Urban Development, NBS began an experimental survey of 4,000 residences in Pittsburgh, Penn., to determine the nature and extent of

the lead-based paint poisoning problem. NBS chemists are also developing a more precise standard for measuring lead levels in blood. They are working on a standard based on blood taken from pigs that have been fed lead compounds. This standard, to be issued as an official Standard Reference Material, is expected to be biochemically representative of the blood samples obtained from children.



Physical and chemical properties of bone cement evaluated.



NBS developing standard to measure lead levels in blood.

Advancing Computer Technology

The export of U.S. computers affects both the international balance of trade and the balance of power. During fiscal 1974 NBS provided advice on the technological significance of exporting large-scale computers, such as systems for the Soviet Union's Kama River truck plant and its Aeroflot (airline) reservation system.

Public concern over computer-based record keeping

and its implications for the personal privacy of two hundred and eleven million Americans escalated NBS' program in computer security to one of high priority. The potential for damage to people's reputations and credit ratings necessitates standards and guidelines to prevent the misuse of computerized personal data files.

NBS provided technical support to the Congress and the Domestic Council's Committee on the Right of Privacy in the development of national policies for the collection, use and distribution of personal information. Federal standards for controlling access to automated information systems were being issued and collaborative efforts were underway to provide voluntary standards for the private sector. Two privacy conferences hosted by NBS brought together 800 representatives of business, consumers, government and the computer industry to assess the problem and propose resolutions.

The Bureau published the first set of guidelines for computer security which specify how to structure physical security programs for Federal computer facilities. Additionally, a special computer security guide for business executives was distributed to acquaint them with safeguards which assure protection of computerized information.

Automated robot responds to human control.



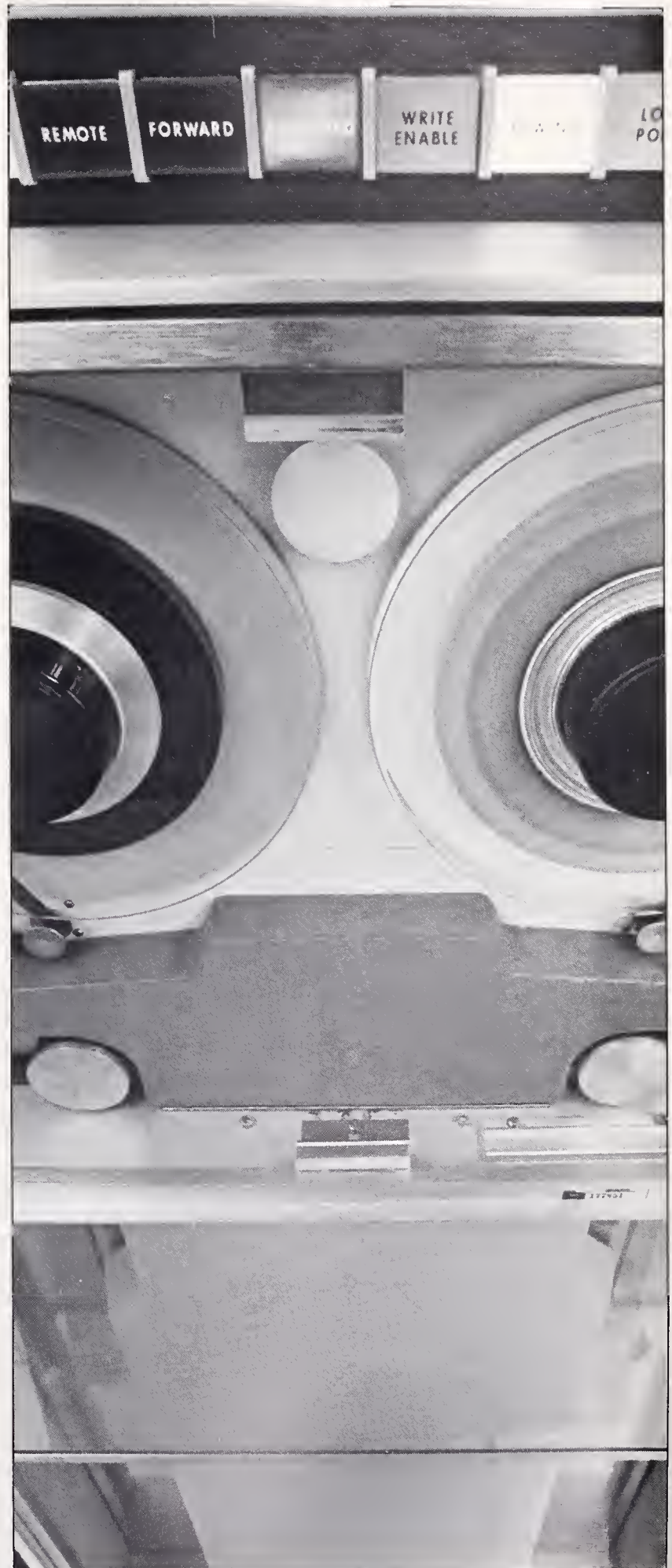
Bureau established guidelines for computer security.



In the field of automation technology, NBS developed a mobile robot for the Navy that can be used in place of humans in hazardous environments. This is an example of efforts to advance computer-based automation technology that can either increase productivity or relieve humans from hazardous, tedious or unpleasant tasks.

Computer experts perfected an automated method for processing tax payments for the Internal Revenue Service. The new method replaces several time-consuming manual operations with one computer-controlled system. NBS also began a 1-year contract with the General Accounting Office to assess computers as vote counters. Guidelines should result that assure accuracy, prevent fraud and provide immediate data to election officials.

For the Federal Bureau of Investigation, NBS made progress in the development of computer systems that allow quick identification of fingerprints. As a service to American industry, NBS made available a computer program package for conversion of customary units of measurement into metric units. The Bureau also helped develop standards for writing and documenting computer programs in MUMPS, a medical computer language. These standards will facilitate the transfer of computer programs among medical institutions.



Interaction Is The Key

The Bureau doesn't operate in a vacuum. It has numerous daily contacts with persons in other government agencies, with trade associations, with industrial representatives and with an inquisitive American public. There are also formal programs designed to promote interchange between NBS and the nation's academic and industrial communities.



Glassblowers at work during Open House



Thousands call time-of-day service

Public Interest

The Bureau is popular with many members of the American public. Most of the letters received in fiscal 1974—up to 1,000 per week—wanted more facts about the metric system. NBS is a Federal focal point for metric information and, as such, responds to requests from teachers, students, businessmen and the just plain curious. A new NBS booklet, "What About Metric?," became a fast-selling item in Federal bookstores.

Most of the phone callers were looking for the time of day. And the Bureau offered it. Through its special number in Boulder, Colo. (303/499-7111), NBS offers a time-of-day service that is accurate to 30 milliseconds (30 one-thousandths of a second) as received by the caller. An average of 13,000 companies and individuals each week set their watches and clocks by Bureau standards. On its third birthday, in November 1973, the service logged its one millionth call.

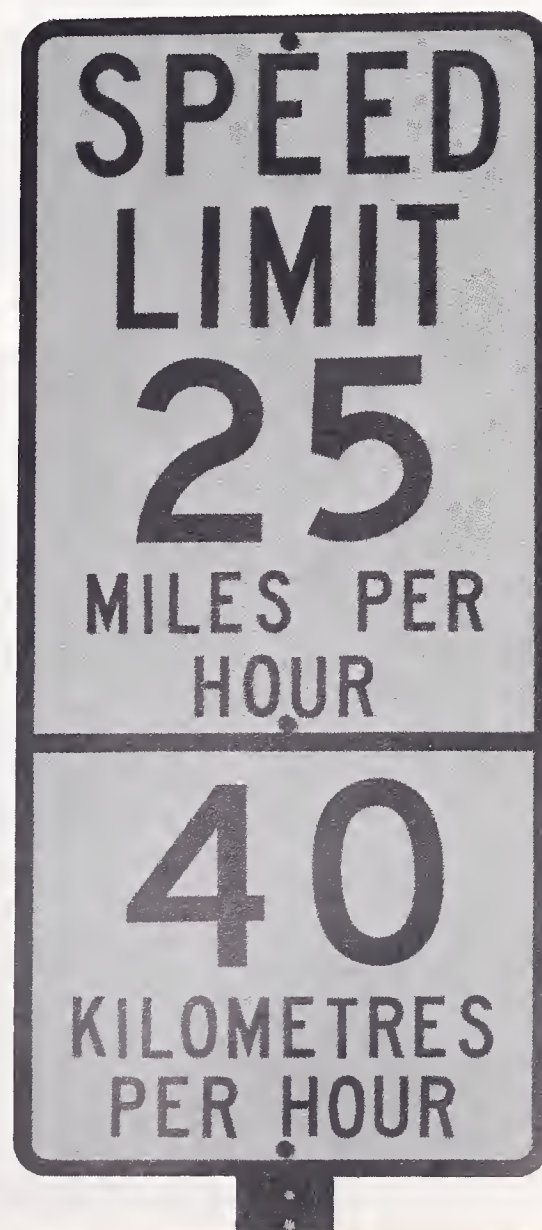
The Bureau's public contacts were highlighted by an open house in the fall of 1973 at the Gaithersburg headquarters. The Bureau opened 100 of its laboratories and put on special demonstrations for its 35,000 visitors. A similar open house was planned for the fall of 1974 in Boulder. NBS also hosted 56 major national and international conferences during the year.

Government Projects

Another significant form of interaction consists of the promotion of technology transfer between the Federal and State governments and private industry. A major NBS effort in this area is the Experimental Technology Incentives Program which in fiscal 1974 encouraged other Federal agencies to commit major resources towards experiments in technology transfer. One objective is to use the Federal government's purchasing power as an incentive to encourage private firms to redesign their products with technological improvements as a goal. Other objectives are to develop methods and procedures by which government regulatory powers and research and development systems can provide incentives for technological changes.

As indicated in the highlights of fiscal 1974 activity, the Bureau serves as a major research center for other Federal departments and agencies. Among these are the Departments of Defense, Transportation, Justice, Housing and Urban Development, Health, Education and Welfare, the Atomic Energy Commission, the National Aeronautics and Space Administration and the Consumer Product Safety Commission. NBS also serves as the secretariat (headquarters) for the National Conference on Weights and Measures and the National Conference of States on Building Codes and Standards.

The Bureau presented three states with new sets of standards for weights and measures. The sets are used to calibrate field equipment that checks scales and other measurement instruments for accuracy. Until the Bureau launched its replacement program in 1966, many states operated with bars and balances that were 100 years old and older. New York, Florida and Colorado were the latest recipients. They joined 39 other states that have already received new sets of standards to provide better protection for the consumer at the supermarket scales, the gasoline pump or wherever goods are measured and sold.



Metric information provided by NBS.

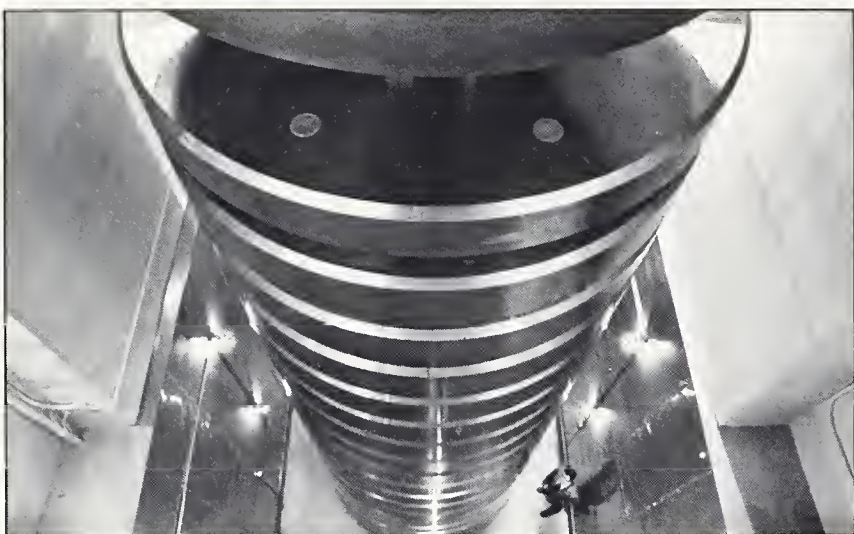
Industry Cooperation

The Research Associate Program allows scientists and engineers from industrial, professional and trade organizations to work at NBS for specified periods on a full-time basis, under sponsorship of their employers. Their projects are of mutual interest to the sponsor and to NBS. This program experienced considerable growth in fiscal 1974. Twelve new projects were started

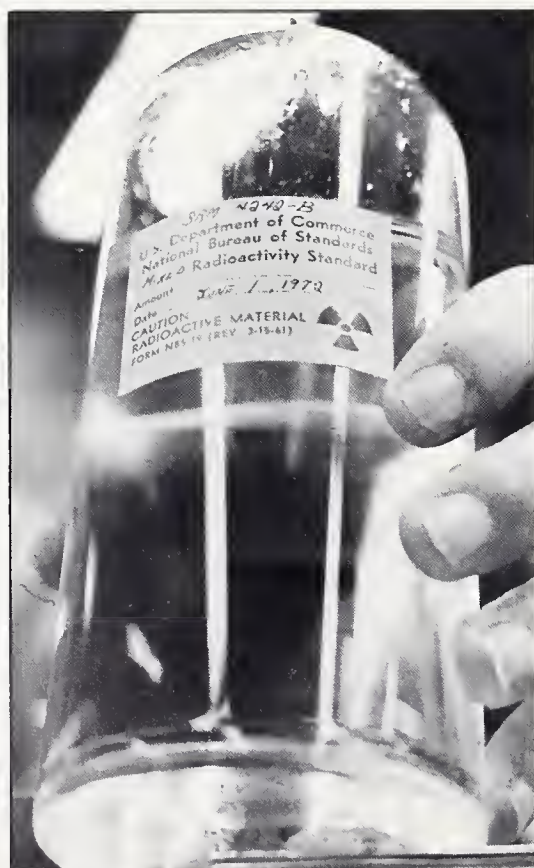
and seven were extended for a year. Negotiations were underway for 11 additional projects. At the end of the year there were 64 Research Associates at NBS representing six industrial companies and 15 trade and professional organizations.

NBS experts provide industry and commerce with a \$2 million-a-year advertised, reimbursable calibration service covering a wide range of physical measurements. As one example, NBS high-voltage experts calibrated equipment of a major electric company's ultra high voltage test facility. This gave the company confidence in the accuracy of its services.

Bureau staff members also perform a variety of other outside tasks. Some hold part-time teaching positions in nearby colleges and universities and about 350 serve on 1,150 technical committees sponsored by private standards-writing organizations. The Bureau's link with the voluntary standards system is strengthened by the NBS director serving on the Board of Directors of the American National Standards Institute and by a NBS executive serving on the Board of Directors of the American Society for Testing and Materials.



Weights for the NBS universal testing machine.



More than 30,000 Standard Reference Materials sold annually.

Information Services

If the Bureau has any single product it is information. In addition to public information programs that reach a wide audience through such means as distribution of consumer-oriented publications, NBS operates several information services designed to serve specific audiences.

The publication of formal scientific and technical papers and reports is a major NBS activity. Over 1,000 titles were published in fiscal 1974. NBS has 13 publication series of its own.

The scientific and engineering community is served by the National Standard Reference Data System (NSRDS). It consists of a network of more than two dozen data evaluation and analysis centers at NBS and other laboratories. NSRDS produces critical reviews and compilations of critically evaluated data covering the broad field of physical and chemical properties of substances.

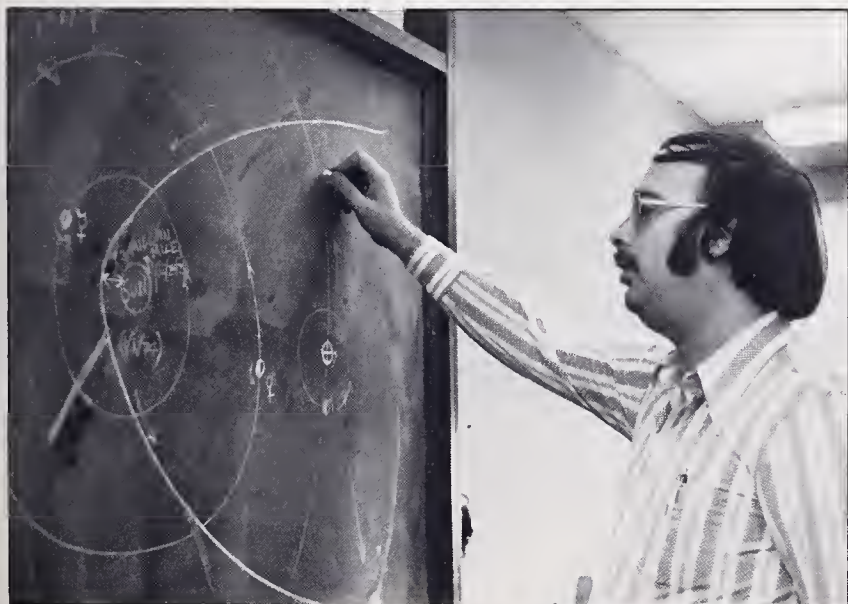
NBS also operates an Engineering Standards Information Center. It handles approximately 5,000 inquiries annually from the public and from other government agencies on the

availability and source of national, foreign, international, industrial and State and Federal government standards. The center maintains a library of more than 200,000 standards.

Another major information service is the Standard Reference Materials (SRM's). Since 1910, NBS has provided a wide variety of materials that are used by science, industry and the technical community to calibrate accurately many kinds of measurement systems. More than 800 different SRM's are available from NBS and about 30,000 are sold each year. For example, in the area of health, NBS has prepared 20 SRM's to improve the accuracy of clinical measurements. The cholesterol SRM, produced in 1967, provided clinical laboratories a means to evaluate their measurements. NBS also recognizes the need to improve cholesterol measurement techniques and conducted studies to identify and eliminate the factors that adversely affect the accuracy of these measurements.

In the computer field, NBS develops and recommends to the Secretary of Commerce, Federal Information Processing Standards that increase the economy and effectiveness of government computer operations. The standards are aimed towards improving compatibility, interchange and performance of machines and programs.

Bureau staff member teaching in nearby college.



Funds and Facilities

To operate its many programs and services in fiscal 1974, the Bureau received about \$100 million. Sixty percent of this money came from direct Congressional appropriations, 34 percent came from other government agencies for which NBS performed work and the remaining 6 percent came from the sale of goods and services, such as Standard Reference Materials and calibrations. NBS Congressional appropriations have increased about 10 percent for each of the last 5 years. Much of this money has gone to meet the costs of inflation and salaries, and to increasing the amount of contract work performed by private firms outside the Bureau. Funds from other agencies have also been rising since 1969, marked by an increasing shift of these funds from defense and space work to health, environment and other social programs.

NBS work is carried out at two main locations. Its headquarters are on a 233-hectare (1 hectare equals 2.5 acres) site in Gaithersburg, Md., northwest of Washington, D.C. Twenty-three buildings on the site are arranged in a campus-like setting and are located to provide maximum protection from such interference as noise vibration and electromagnetic radiation.

The Bureau's other major facility is located at Boulder, Colo.

There, with 14 buildings on 83 hectares of land, the Bureau conducts research in the fields of cryogenics (very low temperatures), electromagnetic measurements, time and frequency standards, and quantum electronics. On the nearby University of Colorado campus NBS conducts a major program in atomic and molecular physics at the Joint Institute for Laboratory Astrophysics.

NBS has a field station in Fort Collins, Colo., for Standard Frequency and Time Interval Broadcast Stations WWV, WWVB, and experimental station WWVL. Another station, WWVH, is operated on Kauai in the Hawaiian Islands. The Bureau also has a facility at Clearing, Ill., which maintains a railway master track scale and two test cars that travel around the country calibrating 17 master track scales owned by railroads.

NBS has a staff of 3,100 employees—approximately 2,600 at Gaithersburg and 500 at Boulder. Some 45 percent of the staff are scientists and engineers and 12 percent are technicians. Forty percent of NBS scientists and engineers have Ph.D. degrees. The balance of the staff consists of administrative and clerical support as well as housekeeping and grounds personnel.

Total NBS Operating Funds (all sources)

(in millions of dollars)

| | fiscal 1973 | fiscal 1974 | fiscal 1975 (est.) |
|---|-------------|--------------|-----------------------|
| Provide a national system for physical measurement | 30.5 | 31.7 | 32.5 |
| physical measurements, units and standards | 21.2 | 22.0 | 22.7 |
| reference measurements for physical quantities | 9.3 | 9.7 | 9.3 |
| Provide services to improve use of materials | 19.7 | 22.0 | 22.2 |
| properties and performance of materials | 14.3 | 16.1 | 16.5 |
| reference materials | 1.7 | 2.1 | 2.0 |
| environmental pollution measurements | 3.7 | 3.8 | 3.7 |
| Provide services to improve the application of technology | 22.1 | 28.1 | 31.4 |
| state weights and measures services | .5 | .6 | .6 |
| voluntary engineering standards | 1.5 | 1.7 | 2.0 |
| building science and technology | 7.4 | 8.9 | 9.3 |
| electronic technology | 2.9 | 3.3 | 4.2 |
| cryogenic technology | 1.5 | 1.8 | 1.7 |
| product performance and safety | 4.3 | 5.8 | 7.9 |
| radiation safety | .6 | .8 | 1.0 |
| fire research | 3.0 | 4.9 | 4.4 |
| illumination technology | .3 | .3 | .3 |
| Improve the application of computer technology | 10.0 | 9.8 | 10.6 |
| Support services to other agencies | 2.2 | 2.5 | 2.8 |
| Experimental Technology Incentives Program | .8 | 6.1 | 4.4 |
| Total | 85.3 | 100.2 | 104.3 |

Organization

The NBS staff is organized into four major institutes:

- The Institute for Basic Standards (IBS) provides the central base within the United States for a complete and consistent system of physical measurements and coordinates that system with measurement systems of other nations. It furnishes the research and essential services leading to accurate and uniform physical measurements and reliable data

throughout the nation's scientific, industrial and commercial communities. IBS also operates the Boulder Laboratories and cosponsors the Joint Institute for Laboratory Astrophysics with the University of Colorado.

- The Institute for Materials Research (IMR) conducts research to provide a better understanding of the basic properties of matter and materials and develops standards for measuring their properties to help



NBS proving ring used for calibration services.

insure their proper utilization by the Nation's scientific, industrial and commercial communities. IMR also develops, produces and distributes Standard Reference Materials which provide a basis for calibration of instruments and equipment, comparison of measurements on materials and aid in the control of production processes in industry.

- The Institute for Applied Technology (IAT) is concerned with technological development and engineering standards in such areas as building construction, fire research and safety, consumer product performance and safety and electronics. IAT represents the public interest in the development of voluntary engineering standards; develops standards, tests and services to protect the public from hazardous products. The institute also promotes the performance concept for evaluating components, products and technological processes in such areas as building construction.

- The Institute for Computer Sciences and Technology (ICST) is the scientific and technical arm of the Federal government's automatic data processing management system. In this role, ICST provides advisory services to Federal agencies to support the formulation of automatic data processing management and procurement policies and to assist individual agencies in solving specific automation problems.

ICST also develops Federal Information Processing Standards and conducts research in computer science and technology.

The institutes are supported by the Office of the Associate Director for Administration, the Office of the Associate Director for Programs, which performs policy development and program analysis and planning, and the Office of the Associate Director for Information Programs, which focuses the flow of information into and out of NBS and which manages the National Standard Reference Data System.

This amalgam of people and programs forms a community dedicated to service. As the Bureau approaches its 75th anniversary, in 1976, there is unity within diversity. Accuracy and precision are hallmarks of the National Bureau of Standards. They were present at its creation in 1901 and continue to live in the people and the work they produce.



The Boulder campus.

People

The National Bureau of Standards was created by Congress in 1901 to meet the needs of a growing nation for a unified measurement system. From the beginning, the primary resource contributing to the fulfillment of that mandate has been people. People who provide leadership and guidance, lend support, assume responsibility and strive to excel.

Today, there are many individuals who work cooperatively toward the NBS goal of advancing the nation's science and technology and promoting the effective application of science and technology for public benefit. During fiscal 1974, the NBS Executive Board was responsible for the day-to-day operation of all Bureau programs and activities.

NBS also relied heavily during the year on the advice and counsel provided by several panels of distinguished advisors who evaluate the functions and operations of the Bureau. The NBS Visiting Committee, created by statute in 1901, conducted its annual review and advised the Secretary of Commerce on the "efficiency of the Bureau's scientific work and condition of its equipment."

In addition, the NBS system of Evaluation Panels met and reviewed in detail the plans and activities of each technical division and Institute at the Bureau. These panels are appointed by the National Academy of Sciences, the National Academy of Engineering and the National Research Council. Members of these panels in turn formed an Executive Committee to consider problems, issues and policies that are common to more than one area of NBS activity and report to the Director of NBS and the Visiting Committee on the key findings and recommendations of individual panels.

Finally, a number of NBS staff members were singled out by independent and private sector organizations and honored for the economic and social benefits which resulted from their work at the Bureau.

NBS Executive Board

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Deputy Director

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Associate Director for Programs

Robert S. Walleigh
Associate Director
for Administration

Dr. E. L. Brady
Associate Director
for Information Programs

Dr. A. O. McCoubrey
Director,
Institute for Basic Standards

Dr. J. D. Hoffman
Director,
Institute for Materials Research

Dr. F. K. Willenbrock
Director,
Institute for Applied Technology

Dr. Ruth M. Davis
Director, Institute for
Computer Sciences and Technology

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Xerox Corporation

Dr. Arthur M. Bueche
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Research and Development
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Dean, College of Engineering
State University
of New York at Stony Brook

Charles E. Peck
Vice President, Construction Group
Owens-Corning Fiberglas Corporation

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SpectraVision, Inc.

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(Chairman, Institute for
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Harvard Business School

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Vice President
Research and Development
General Electric Company

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Reference Data Panel)
Department of Metallurgy
and Materials Science
Massachusetts Institute of Technology

Dr. N. B. Hannay
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Vice President-Research and Patents
Bell Laboratories

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Vice President-Technical Services
Owens-Corning Fiberglas Corporation

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(Chairman, Institute for
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Research and Development Manager
Physical Science and Engineering
General Electric Research
and Development Center

Dr. I. C. Schoonover
(Member-at-Large)
retired, Deputy Director
National Bureau of Standards

Michael Witunski
(Member-at-Large)
McDonnell Douglas Corporation

Evaluation Panel Institute For Basic Standards

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Research and Development Manager,
Physical Science and Engineering
General Electric Research
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Department of Physics
University of California
at Santa Barbara

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Department of Electrical Engineering
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Department of Applied Mechanics
and Engineering Science
University of Michigan

Professor Ronald Geballe
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Associate Dean
College of Art and Sciences
University of Washington

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Research Department
Central Institute for the Deaf

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Department of Physics
University of Pennsylvania

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Senior Chemist
Argonne National Laboratory

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Douglas C. Strain
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Department of Metallurgy
and Materials Science
Massachusetts Institute of Technology

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Division Panel)
Assistant Chemical Director
Bell Laboratories

Dr. Herbert I. Fusfeld
Director of Research
Kennecott Copper Corporation

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(Chairman, Metallurgy Division Panel)
Senior Fellow,
Materials Science Department
Battelle Columbus Laboratories

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Head, Physics Department
General Motors Technical Center

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Chemical Director
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Charles J. Meehan
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Research and Engineering
Rockwell International

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Division Panel)
Department of Chemistry
Cornell University

Dr. R. J. Stokes
(Chairman, Inorganic Materials
Division Panel)
Manager, Materials Science Department
Honeywell Corporate Research Center

Dr. Max L. Yeater
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Professor and Curriculum Chairman,
Nuclear Engineering
School of Engineering
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Division of Engineering
and Applied Physics
Harvard University

S. David Freeman
Project Director
The Energy Policy Project

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President
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Dr. Hubert Heffner
Professor, Applied Physics and
Electrical Engineering
Stanford University

Henry Rowen
(Chairman, Technical Analysis
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School of Business Administration
Stanford University

Dr. Gordon K. Teal
(Chairman, Electronic
Technology Division Panel)
retired, Texas Instruments, Inc.

Dr. G. King Walters
Department of Physics
Rice University

Dr. Paul Weidlinger
(Chairman, Center for
Building Technology Panel)
Weidlinger Associates,
Consulting Engineers

Foster C. Wilson,
(Chairman, Programmatic Center
for Consumer Product Safety Panel)
Group Manager
Owens-Corning Fiberglas Corporation

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SpectraVision, Inc.

Dr. Jordan Baruch
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Harvard University Graduate School of
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Graduate School
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Cornell University

Dr. Kurt E. Shuler
University of California at San Diego
Revelle College
Department of Chemistry

Dr. Daniel Teichroew
Professor, Department of Industrial and
Operations Engineering
University of Michigan

Dr. T. F. Walkowicz
National Aviation Corporation

Alfred R. Zipf
Executive Vice President
Bank of America

NBS Award Winners

• *Marshall Isler, program manager in the Law Enforcement Standards Laboratory, was selected for the Congressional Fellowship Program. He was only the second NBS employee to be so honored.*

• *Dr. Ruth M. Davis, director of the Institute for Computer Sciences and Technology, won a coveted Rockefeller Public Service Award for her leadership in the field of computer technology.*

• *Dr. John D. Hoffman, director of the Institute for Materials Research, was elected to a 3 year term on the American Society for Testing and Materials Board of Directors.*

• *Dr. Alexander F. Robertson, technical assistant in the fire programs, won the S. H. Ingberg Award of the American Society for Testing and*

Materials' Committee E-5 on Fire Tests of Materials and Constructions. It was awarded for outstanding achievements in fire resistance research and in fire loss prevention.

- **Marguerite R. Hubanks**, a management analyst, received an award for outstanding achievement for the Association of Records Executives and Administrators. It was the first such award presented to an NBS employee.

- **Thomas N. Pyke, Jr.**, acting chief of the Computer Systems Engineering Division, received the Washington Academy of Sciences' Award for Scientific Achievement in Engineering Sciences.

- **Dr. David G. Hummer**, chairman of the Joint Institute for Laboratory Astrophysics, received an Arthur S. Flemming Award which honors outstanding young government executives.

- **Robert Griffin**, an information specialist in the Product Evaluation Technology Division, won a first-place award from the Federal Editors Association for his editing of the NBS booklet, "What About Metric?"

- **Charles A. Douglass** of the Optical Radiation Section, Heat Division, received the Federal Aviation Administration's Award for Extraordinary Service for his achievements in designing and developing aviation lighting systems.

- **Forest K. Harris**, consultant to the Electricity Division, received the Si Fluor Achievement Award from the Instrument Society of America for his advancements in the knowledge of absolute electrical measurements and for publication of *Electrical Measurements*, considered a landmark textbook.

- **Charles G. Culver**, of the Office of Federal Building Technology, won the Walter L. Huber Civil Engineering Research Prize of the American Society of Civil Engineers. He was chosen for his contributions to structural research, particularly composite beams, curved highway bridges and steel columns.

- **William C. Cullen**, a chemist in the Center for Building Technology, received the J. A. Piper Award from the National Roofing Contractors Association for his work in roofing technology.

- **Dale E. Newbury**, of the Surface Microanalysis Section, received the 1973 Robert Lansing Hardy Gold Medal of the Metallurgical Society of the American Institute of Metallurgical Engineers (AIME), "in recognition of exceptional promise of a successful career in the field of metallurgy."

- **Paul F. Roth**, a computer specialist, in the Institute for Computer Sciences and Technology, was honored by the Association for Computing Machinery, for "significant achievement in simulation."

- **Bourden Scribner**, retired deputy chief of the Analytical Chemistry Division, was notified that the American Society for Testing and Materials Committee on Emission Spectroscopy has established the B. F. Scribner Award for "outstanding service to the committee."

- **Robert D. Cutkosky**, acting chief of the Absolute Electrical Measurements Section, was elevated by the Institute of Electronic and Electrical Engineers (IEEE) to the grade of Fellow.

- **Gordon M. Kline**, retired chief of the Polymer Division, was one of eleven persons elected to inaugurate the newly established Plastics Hall of Fame. Kline was elected for "his extensive and significant work in the science and technology of plastics."

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and
Technology

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Legal Adviser
Office of Professional
and
Academic Liaison
Office of Engineering
and Information
Processing Standards

Director
Deputy Director

Office of the
Associate Director
for Programs

Office of
Experimental
Technology
Incentives Program

